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MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF VASSAR COLLEGE

XXVII. THE INFLUENCE OF SUPPRESSING ARTICULATION ON THE FAVORABLE EFFECT OF DISTRIBUTING REPETITIONS

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In Study Number XXIII from this laboratory, which appeared in the *AMERICAN JOURNAL OF PSYCHOLOGY*, vol. 24, pp. 580-582, it was shown that a series of hand and arm movements could be learned with fewer repetitions if an interval of one minute was allowed between the repetitions than if the series of movements was performed again and again without interval. Attention was of course distracted to prevent conscious recall of the movements during the one minute interval. This instance of the working of Jost's Law in a learning process where the motor factors involved were not articulatory suggested the possibility that the law might be primarily concerned with motor processes. In the present study we undertook to investigate the value of the one-minute interval in the learning of nonsense syllables where the articulatory or motor factors were strengthened and where they were interfered with or weakened. If Jost's Law is primarily a law of the learning of movements, then we should expect to find the one-minute interval most favorable when the motor processes in learning syllables are most strongly emphasized.

To find out whether this was the case, we adopted a method which enabled us to work with a number of observers almost unprecedented in memory investigations, and as in the case of Study Number XXIII allowed us wholly to eliminate the effects of practice. It was based on the Method of Retained Members. Six series of ten nonsense syllables each were prepared according to the rules laid down by Mueller and Schumann. They were called Series A, B, C, D, E, and F. These series were used by each observer in the same order, that is, A was always the first one used, then series B, and so on to series F. The syllables were printed each on a separate card, and were laid singly and successively before the observer in time to the beats of a metronome set at sixty; two beats were allowed for each exposure and two for the change of cards. The series was in every case presented four times to the observer, who at the end of the fourth presentation recalled as many of the syllables as she could. In the case of two of the six series presented to a given observer, she was instructed to pronounce each syllable silently as she looked at it. In the case of two other series, she was instructed to try to avoid pronouncing the syllables to herself, and to learn them as nearly as possible wholly by vision. In the case of the remaining two she was instructed to articulate silently, as she looked at each syllable, the syllable 'Deb.' These three methods will be referred to as the articulation method, the no-articulation method, and the Deb method. With one of the two series apprehended by each method, an interval of one minute, during which the observer's

attention was distracted, was allowed to elapse between each presentation of a series and the next. With the other one, the interval between presentations was only four seconds, just enough to mark the end of a presentation.

The influence of practice and of the varying difficulty of the series was eliminated in the following way. Twelve different orders of experiment were used, each with a different observer. The first order was: Series A, by the no articulation method, with four second interval; Series B, no articulation, one-minute interval; Series C, articulation method, four seconds interval; Series D, articulation method, one-minute interval; Series E, Deb method, four seconds interval; Series F, Deb method, one-minute interval. The second order was: Series A, no articulation, one-minute interval; Series B, no articulation, four seconds interval; Series C, articulation, one-minute interval; Series D, articulation, four seconds interval; Series E, Deb method, one minute interval; Series F, Deb method, four seconds interval. The third order was: Series A, no articulation, four seconds interval; Series B, no articulation, one-minute interval; Series C, Deb method, four seconds interval; Series D, Deb method, one-minute interval; Series E, articulation, four seconds interval; Series F, articulation, one-minute interval. The fourth order was: Series A, no articulation, one-minute interval; Series B, no articulation, four seconds interval; Series C, Deb method, one-minute interval; Series D, Deb method, four seconds interval; Series E, articulation, one minute interval; Series F, articulation, four seconds interval. The fifth order was: Series A, articulation, four seconds interval; Series B, articulation, one-minute interval; Series C, no articulation, four seconds interval; Series D, no articulation, one-minute interval; Series E, Deb method, four seconds interval; Series F, Deb method, one minute interval. The sixth order was: Series A, articulation, one-minute interval; Series B, articulation, four seconds interval; Series C, no articulation, one-minute interval; Series D, no articulation, four seconds interval; Series E, Deb method, one-minute interval; Series F, Deb method, four seconds interval. The seventh order was: Series A, articulation, four seconds interval; Series B, articulation, one-minute interval; Series C, Deb method, four seconds interval; Series D, Deb method, one-minute interval; Series E, no articulation, four seconds interval; Series F, no articulation, one-minute interval. The eighth order was: Series A, articulation, one-minute interval; Series B, articulation, four seconds interval; Series C, Deb method, one-minute interval; Series D, Deb method, four seconds interval; Series E, no articulation, one minute interval; Series F, no articulation, four seconds interval. The ninth order was: Series A, Deb method, four seconds interval; Series B, Deb method, one-minute interval; Series C, articulation, four seconds interval; Series D, articulation, one-minute interval; Series E, no articulation, four seconds interval; Series F, no articulation, one-minute interval. The tenth order was: Series A, Deb method, one-minute interval; Series B, Deb method, four seconds interval; Series C, articulation, one-minute interval; Series D, articulation, four seconds interval; Series E, no articulation, one-minute interval; Series F, no articulation, four seconds interval. The eleventh order was: Series A, Deb method, four seconds interval; Series B, Deb method, one-minute interval; Series C, no articulation, four seconds interval; Series D, no articulation, one-minute interval; Series E, articulation, four seconds interval; Series F, articulation, one minute interval.

The twelfth order was: Series A, Deb method, one-minute interval; Series B, Deb method, four seconds interval; Series C, no articulation, one-minute interval; Series D, no articulation, four seconds interval; Series E, articulation, one-minute interval; Series F, articulation, four seconds interval.

Thus each of the six methods of apprehension of the syllables was used with each series and in each time position. Results were obtained from twelve sets of twelve observers each, and each observer, of course, had performed a complete experiment involving the presentation of six series. There were thus one hundred and forty-four observers in all; there was no practice error, and no error due to unequal difficulty of the series.

The results were in the form of the number of syllables correctly retained after four presentations of a series. If a syllable reproduced had two letters in common with one that belonged to the series, but the third letter wrong, it was counted as two-thirds right. The total number of syllables retained by the hundred and forty-four observers when each syllable was silently articulated was, with the four seconds interval, 1,001; with the one-minute interval, it was 1,075.4. The one-minute interval gave an advantage of 74.4 syllables, or 7.3 per cent. of the number learned with the four seconds interval. When the syllables were learned with the attempt to suppress articulation, the total number learned was with the four seconds interval 847.9; with the one-minute interval 879.9, showing a gain for the one-minute interval of 32 syllables, or 3.7 per cent. of the number learned with the four seconds interval. When the syllables were accompanied by the silent articulation of the syllable Deb, the total number learned was, with the four seconds interval, 902.3; with the one-minute interval, 920.0. The amount gained with the one minute interval was thus 17.8 syllables, or 1.9 per cent. of the amount learned with the four seconds interval.

The conclusion that unmistakably follows from these experiments is thus that the advantage which an interval of one minute between repetitions gives over an interval of four seconds only is decidedly greater, about twice as great, when the motor processes accompanying learning are emphasized than when the attempt is made voluntarily to suppress them; and more than three times as great with emphasis on the motor processes than with the suppression of them by the substitution of other motor processes. That such voluntary or artificial suppression of the motor processes could not have been complete; that some articulation of the syllables must have successfully resisted it and even accompanied the articulation of 'Deb' is obvious, but there can be little doubt that the association of the motor processes involved in reading the syllables was more effectually secured when they were given free play than when they were interfered with. It will be seen from the figures given above that both the effort to suppress articulation and the silent pronouncing of 'Deb' operated as distractions; the total number of syllables recalled with full articulation was 2,076.4; with effort to suppress articulation it was 1,727.8; with articulation of 'Deb' it was 1,822.3. It also appears that 'Deb' proved less of a distraction than the effort to suppress articulation; perhaps the silent pronouncing of 'Deb' as each syllable was looked at served to steady attention and keep it from wandering.

Within our experimental conditions, we have good evidence that the law of the superiority of distributed repetitions is chiefly concerned with the motor aspect of learning.